

# Adopting Item Characteristic Curves (ICC) For Invariant of Item Parameters of Polytomous Geography Items in SSCE in Nigeria

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## ABSTRACT

Test stability is an important assessment tool used in assessing of students' performance. This is because the stability of the test gives an equal level or uniform level of assessment of students' abilities which resulted into test invariant. Item response theory is a measurement framework that possesses the characteristic of test invariance. This study was carried out to illustrate the invariant of polytomous geography items in senior school certificate examination in Nigeria using the item characteristic curve. This is a curve that shows the hidden ability level of an examinee. This study examined the extent of invariance of item difficulty estimates across male and female students; and the extent of invariance of item difficulty estimates across Geography students in rural and urban areas. The study employed the descriptive survey design. The population comprised all senior secondary school students in Nigeria. The target population was all senior secondary schools three (SSS3) students that offered Geography in their final examinations in 2016/2017 academic session. The target population for the study was 14,718 in Imo State, 8,433 in Osun State and 9,348 in Kwara State for 2016/2017 academic session. A sample of 1,546 drawn out of 32,499 students from 876 senior secondary schools in Nigeria were selected. A multi-stage sampling procedure involving stratified random sampling, simple random sampling and proportionate sampling technique were used to select the respondents. The research instruments were questions on Element of Practical and Physical Geography (WASSCE 2016 Geography Paper 3). The data collected were analyzed using generalized partial credit model with Mplus 7.4. The findings of the study revealed that, there was a significant invariant of item parameter estimates across male and female geography students and there was a significant invariant of item parameter estimates across rural and urban geography students.

Keywords: Invariant, Item Characteristic Curves, Polytomous Items, Geography

## INTRODUCTION

Educators and psychologists are of concern about the hidden trait /latent traits which is the variable of interest when a test is given to an examinee. This is because latent trait like intelligent which is naturally understood but unobservable cannot be measured directly like weight or height because it is a concept while the latter is a physical dimension. This latent trait can only be measured using the IRT measurement framework which analyse item by item using the ability scale, which ranges from negative infinity to positive infinity. In practice the ability scale is limited to the range of values from +3 to -3. IRT is a theory that

builds around hidden trait ability and the observed ability of the examinee to correctly respond to any particular test item. In the usual assessment method which is the classical test theory, the examinee's raw test score would be the sum of the scores received on the items in the test. However, in item response theory, the primary interest is in whether an examinee got each individual item correct or not rather than in the raw test scores. This is because the basic concepts of item response theory rest upon the individual item of a test rather than upon some total of the item responses such as a test score [1].

The Item Characteristic Curve (ICC) has a reasonable assumption that each examinee that is responding to a test item possesses some amount of the underlying ability. Thus, one can consider each examinee to have a numerical value, a score, which places the examinee somewhere on the ability scale (which is referred to as the ICC). The probability of correct response is near zero at the lowest levels of ability and increases until at the highest levels of ability the probability of correct response approaches unity. This S-shaped curve describes the relationship between the probability of correct response to an item and the ability scale. In item response theory, it is known as the item characteristic curve. Each item in a test will have its own item characteristic curve. The item characteristic curve is the basic building block of item response theory and all the other constructs of the theory depend upon this curve [1].

There are two properties of an item characteristic curve that are used to describe it. The first is the difficulty of the item. In item response theory, the difficulty of an item describes where the item functions along the ability scale. The second property is the discrimination of an item, which describes how well an item can differentiate between examinees having abilities below the item location and those having abilities above the item location. [1]. These two properties are used to describe the form of item characteristic curve and also used to discuss the parameters of an item. IRT has the principle of invariance which makes the examinee's ability to be stable. The invariance principle shows that the item parameters are independent of the distribution of examinees over the ability scale.

When a test is given to different groups of examinees the item parameters should be the same irrespective of their different abilities, when this occurs then we say the items are invariant. It should be noted that invariance includes stability in ability of an examinee that is when tests are given to an examinee for a number of times the ability of that examinee should be stable. Invariance can be described as the ability of a test to be stable overtime in terms of the item parameters (difficulty and discrimination) and the person parameter (ability).

Invariance is a characteristic that shows the values of the parameters that are the same in different populations or across different conditions of interest, which is assessed when they are estimated repeatedly with different samples. In measurement, one need to consider two different groups of population parameters because test data are the result of the intersection of item and examinee sample spaces and the model bind the examinees and items together [2]. Invariance implies that, when an instrument like test is given to different groups of examinees say two, one should be able to say that the parameters of the items are the same therefore the ability estimates of the two groups are the same. It is important to make comment about a specific assessment instrument for groups of examinees that share

characteristics with another group that have being scored with the instrument to show that the scores of the different groups are comparable. Millsap [3] examined impact of measurement bias on the selection procedure and found that violation of measurement invariance could lead to unfair selection with regard to group membership

When a test is utilized across subgroups of a population, it is assumed that the test measures the traits of interest in the same way across all groups. When this assumption does not hold for a variable, the variable could be biased against one or more groups in a test. Glockner-Rist and Hoijsink, [4], explained that the establishment of measurement invariance is especially important in assessing group difference on a measure. In testing, the concept of invariance is that the estimate of the parameter of an item across two or more groups of population of interest different in their abilities must be the same. Also, the estimate of the ability/ person parameter of the same testees based on items which are unequal in their difficulties must also be the same. Hence, with invariance there is "sample free item calibrations" and "item or test- free person measurement.

Glockner-Rist and Hoijsink, [4], posited that measurement of invariance is whether or not, under different conditions of observing and studying a phenomenon, measurement yields measures of the same attributes. If there is no evidence indicating presence or absence of measurement invariance then invariance does not exist, thus the basis for drawing scientific inference is severely lacking then differences between individuals and groups cannot be clearly interpreted.

Nenty [5] Invariance is the base of objectivity in physical measurement, and the lack of it raises a lot of questions about the scientific nature of psychological measurement.

The assessment of cognitive domain in any area will be better studied if the examinees responses are polytomously scored rather than dichotomously scored. Cognitive outcomes may be simply studied using dichotomous scoring but are better done with polytomous scoring. This makes generalized partial credit (GPCM) scoring essential in many assessment situations this is because it believed that it will lead to a more precise estimate of person's ability than a simple pass/fail score.

When a test is used across subgroups of a population, measurement invariance is assumed. This is because test is expected to treat every examinee equally irrespective of the different ability proficiencies. If test does not treat every examinee equally then there is test unfairness. Odili [6] explained test unfairness as a psychometric condition, in which a test item gives differential difficulty to testees of the same subject matter ability, due to the fact that they are from different sub-population of test-takers.

However, Millsap [3] noted that measurement invariance refers to stability in the psychometric properties of a measure across populations or occasions. So, it is assumed that the test measures the traits of interest in the same way through all groups. When this assumption is violated for a variable, the variable could be biased against one or more groups in a test. Glockner-Rist and Hoijtink [4] explained that the establishment of measurement invariance is particularly essential in assessing group difference on a measure. Invariance in assessment is the ability of a test to treat the examinees' equally without bias. It should be noted that invariance includes stability in the ability of the examinee.

Rupp and Zumbo [2] defined invariance as a characteristic that shows the values of the parameters that are the same in different populations or across different situations of interest, which is assessed when they are estimated repeatedly with different samples. In measurement, one need to consider two different groups of population parameters because test data are the result of the intersection of item and examinee sample spaces and the model bind the examinees and items together. In essence, invariance implies that, when an instrument like test is given to different groups of examinee say two, one should be able to say that the item properties measure ability of the examinees equally. It is essential to make comment about a specific assessment instrument for groups of examinees that share characteristics with another group that have being scored with the instrument to show different groups are comparable.

#### **Statement of the Problem**

When assessing students, test is mostly used to determine students' ability or performance. It is expected that test treat every examinee equally irrespective of the different ability proficiencies. If test does not treat every examinee equally then there is biasness.

In most achievement tests, the difficulty levels of items are not usually considered when ability is estimated. This leads to variation in estimating the testees' ability, which shows instability or lack of the principle of invariant. It is important that measurement instrument like test be invariant. This is to say that when a test is administered the characteristic of the items should be the same for all the examinees. For a test to achieve this stability there is a need to use Item Response Theory (IRT). In order to take care of difficulty levels of items regardless of the testees that would respond to the items.

The study tends to investigate test invariant with the use of ability scale which is referred to as item characteristic curve in IRT in polytomous geography items in senior school certificate examination in Nigeria.

#### **Population, Sample and Sampling Techniques**

The population of this study was all public senior secondary school students in Nigeria while the target population was all senior secondary school three students that offered Geography in Nigeria in 2016/2017 academic session. The target population for the study was 14,718 in Imo State, 8,433 in Osun State and 9,348 in Kwara State for 2016/2017 academic session. Multistage sampling procedure was used for the selection of the sample (respondents) at different stages of sampling. At the first stage, Nigeria was stratified into 6 geo-political zones (that is North East; North West; North Central; South West; South East; and South South). At the second stage, simple random sampling technique was used to select three geopolitical zones from the existing six geo-political zones in Nigeria. The three geo-political zones selected were South East, South West and North Central. At the third stage, simple random sampling technique was used to select a state each from the three geopolitical zones chosen to make a total of three states as sample for the study. The three states selected were; Imo, Osun and Kwara. There are 274 public senior secondary schools in Imo State, 255 public senior secondary schools in Osun State and 347 public senior secondary schools in Kwara State. Ten percent of the schools in each state were sampled using simple random sample. A total number of 86 schools were sampled and all SSS 3 geography students in each of the school selected constituted the sample for the study. This is because geography is no more a compulsory subject so very few students offer geography in schools. A total number of 1546 geography students made the sample size for the study.

#### **Instrumentation**

The instrument used for data collection was Essay items of Physical Geography which was selected from WASSCE 2016 Geography Paper 3 (Element of Practical and Physical Geography). The instrument was Physical Geography Achievement Test (PGAT) consisted of eight items and the students were instructed to answer questions one and any other three making a total of four questions in all. Since IRT involves the analysis of item by item, the total number of the item in the study was 23 items in all.

#### **Data Analysis and Interpretations**

##### **Research question 1:**

How invariant is the difficulty estimate of test items among male and female students?

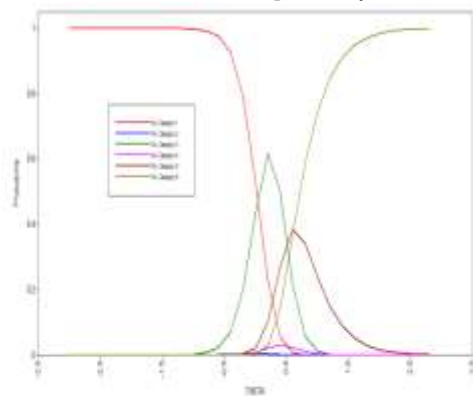
To answer this research question, the scores of all the 1546 students was divided into two (male and female). The male scores as well as the female scores were subjected to generalized partial credit model with Mplus 7.4 so as to obtain the difficulty estimate of test items of male and female students. The difficulty estimates for male and female is shown in table 1 followed by the item characteristics curves of each of the item as responded to by male and female respectively to explain invariant of the difficulty estimate among male and female.

**Table 1: Difficulty Estimates across Male and Female students' samples**

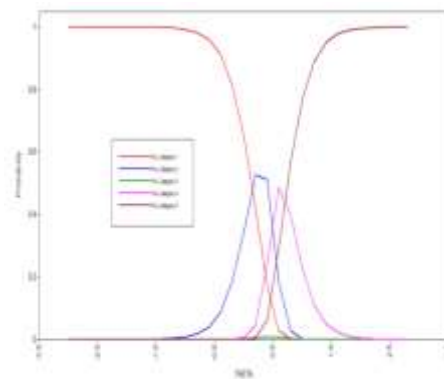
| Items | Male  | Female |
|-------|-------|--------|
| I1A   | 0.501 | 0.421  |
| I1B   | 1.189 | 0.852  |
| I1C   | 1.571 | 1.791  |
| I1D   | 0.743 | 0.847  |
| I2A   | 9.621 | 5.912  |
| I2B   | 2.966 | 62.37  |
| I2C   | -0.95 | -1.18  |
| I3A   | 0.183 | -1.07  |
| I3B   | 2.746 | 2.495  |
| I4A   | 46.51 | 1.621  |
| I4B   | 3.608 | 1.795  |
| I4C   | -1.47 | -3.97  |
| I5AI  | 3.682 | 2.005  |
| I5AII | -0.89 | -2.54  |
| I5B   | 4.091 | 2.626  |
| I6A   | -1.35 | -2.33  |
| I6B   | -1.12 | -1.05  |
| I6C   | 10.62 | 1.924  |
| I7AI  | -1.36 | -1.69  |
| I7AII | -1.5  | -2.91  |
| I7B   | -0.48 | -0.49  |
| I8A   | -0.07 | -0.3   |
| I8B   | 1.863 | 5.439  |
| Mean  | 3.509 | 3.155  |
| STD   | 9.918 | 13.14  |

**MALE AND FEMALE ITEM CHARACTERISTIC CURVES**

The item characteristic curve of the items for male and female students is presented in Figures i1a male and female – i8b male and female i8b respectively.

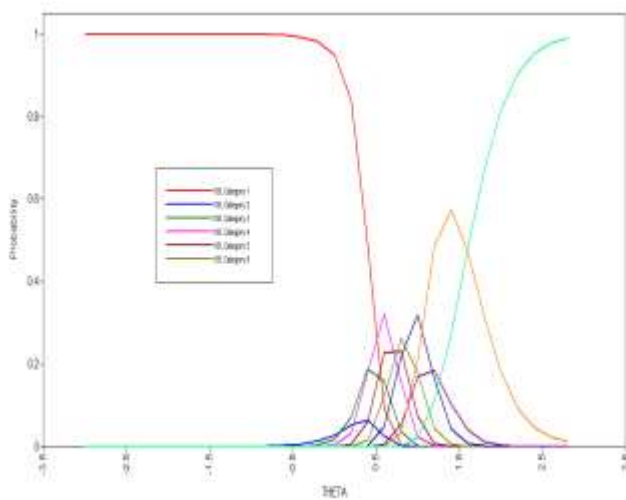


Male i1a

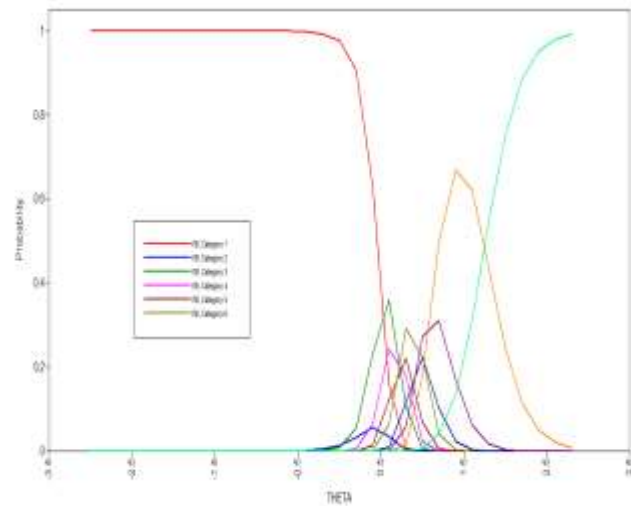


female i1a

The diagram above shows the Item characteristic curve (ICC) for item 1a for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i1a is not invariant.

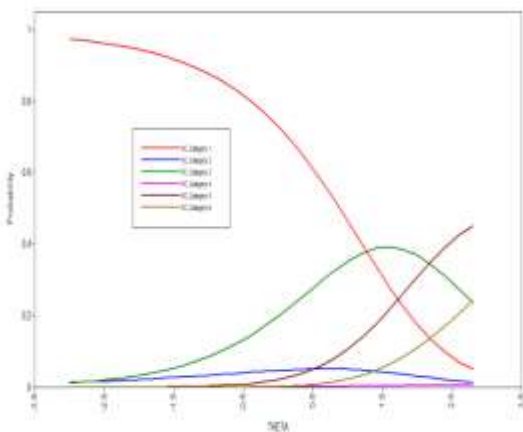


Male i1b

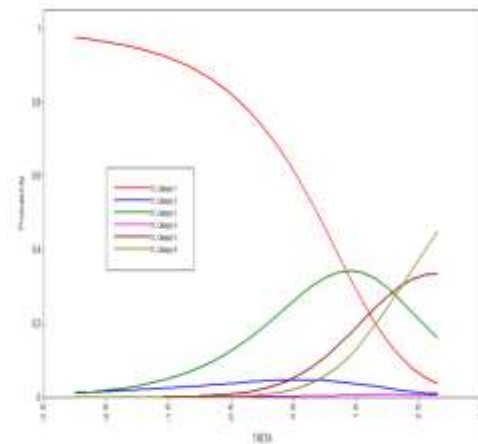


female i1b

The diagram above shows the Item characteristic curve (ICC) for item 1b for male and female students respectively. To answer research question 4, the ICC above were observed to make comparison. It was seen that the two ICC are similar to one another so i1b is invariant.

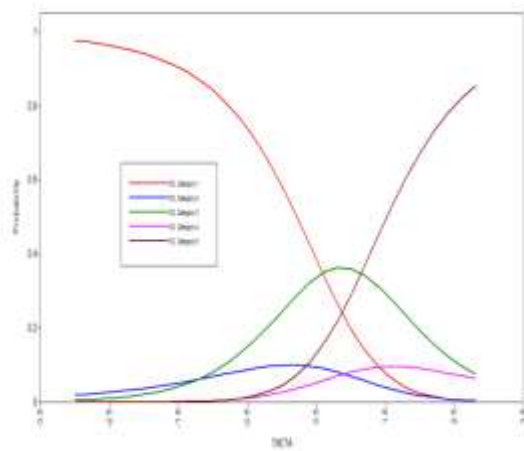


Male i1c

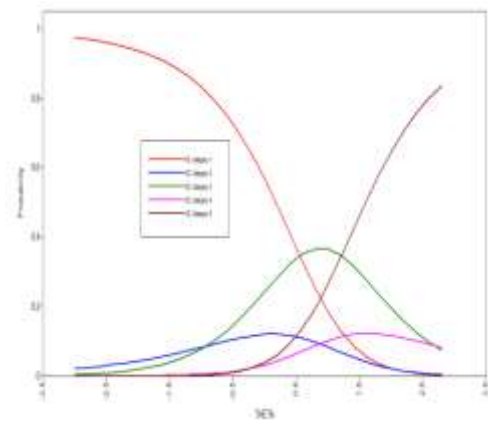


Female i1c

The diagram above shows the Item characteristic curve (ICC) for item 1c for male and female students respectively. To answer research question 4, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i1a is not invariant.

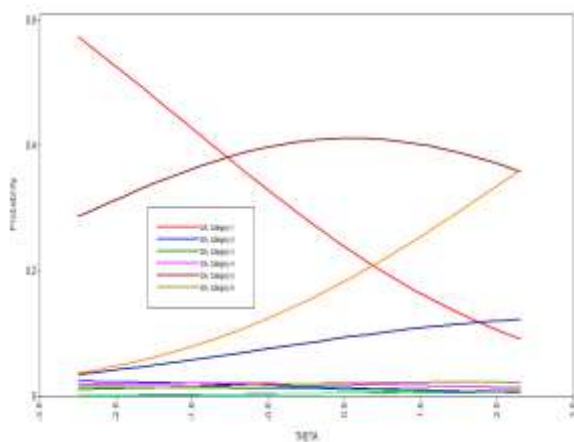


Male i1d

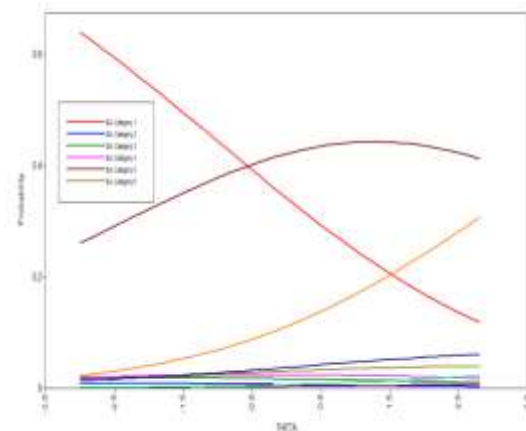


female i1d

The diagram above shows the Item characteristic curve (ICC) for item 1d for male and female students respectively. To answer research question 4, the ICC above were observed to make comparison. It was seen that the two ICC are similar to one another so i1d is invariant.

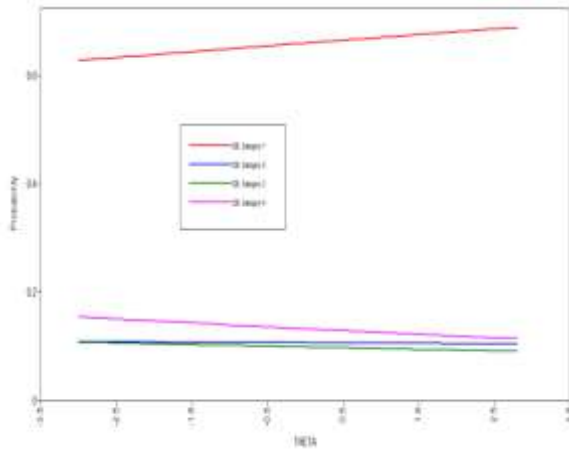


male i2a

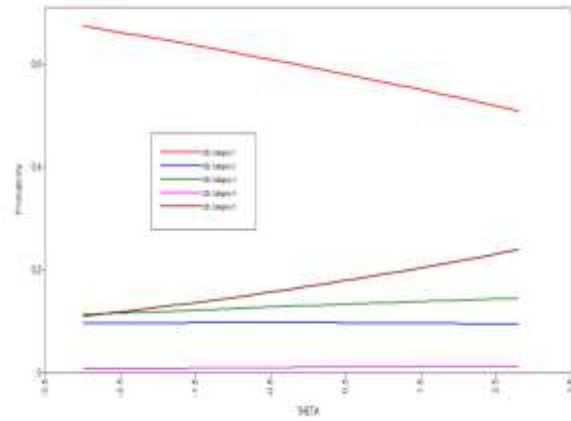


female i2a

The diagram above shows the Item characteristic curve (ICC) for item 2a for male and female students respectively. To answer research question 4, the ICC above were observed to make comparison. It was seen that the two ICC are similar to one another so i2a is not invariant.

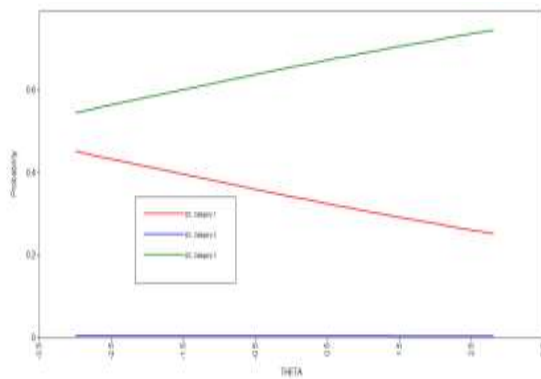


Male i2b

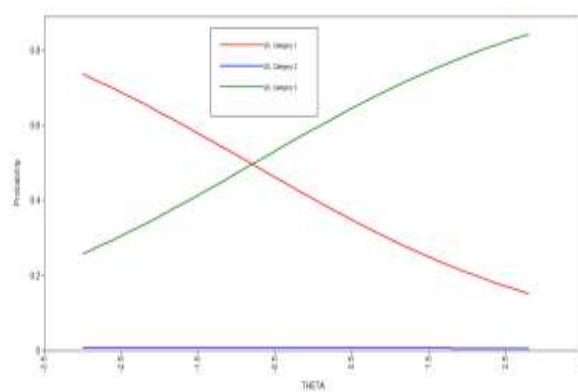


female i2b

The diagram above shows the Item characteristic curve (ICC) for item 2b for male and female students respectively. To answer research question 4, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i2b is not invariant.

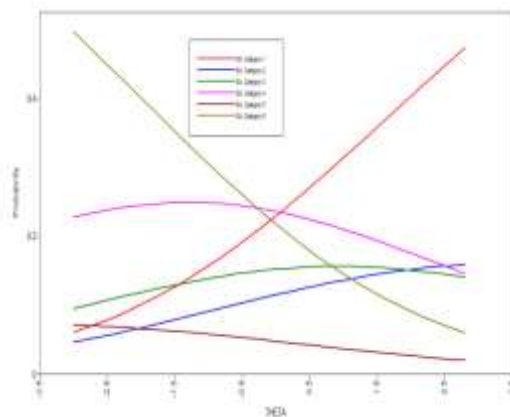


Male i2c

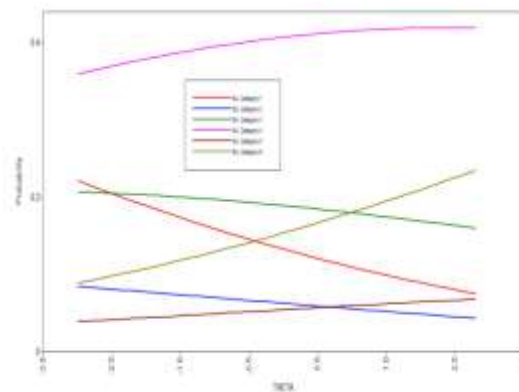


female i2c

The diagram above shows the Item characteristic curve (ICC) for item 2c for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i2c is not invariant.

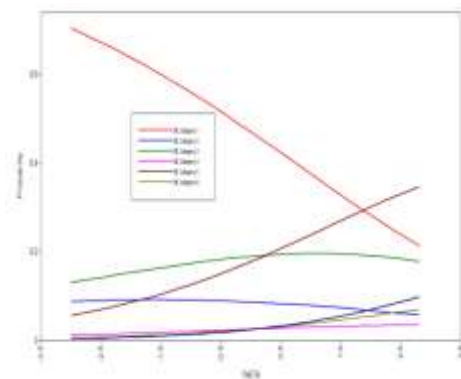


Male i3a

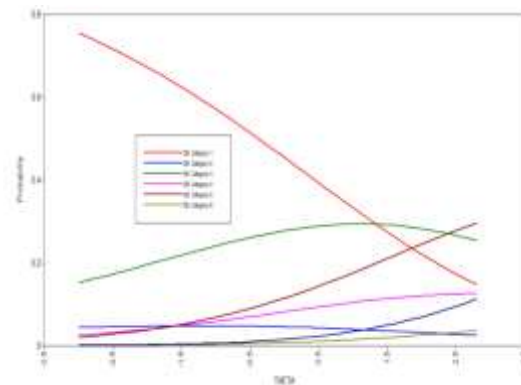


female i3a

The diagram above shows the Item characteristic curve (ICC) for item 3a for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i3a is not invariant.

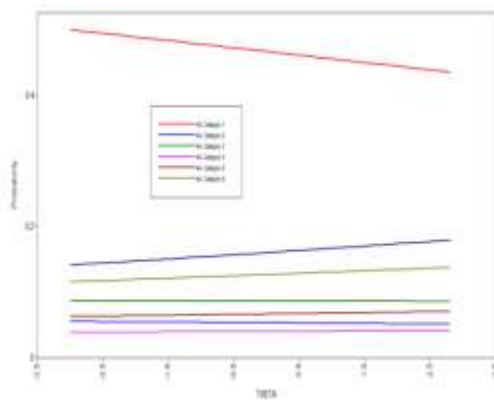


Malei3b

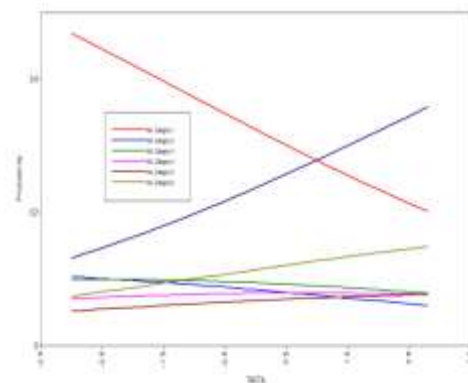


femalei3b

The diagram above shows the Item characteristic curve (ICC) for item 3b for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i3b is not invariant.



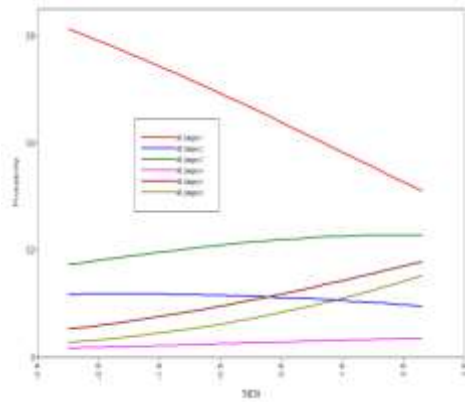
Male i4a



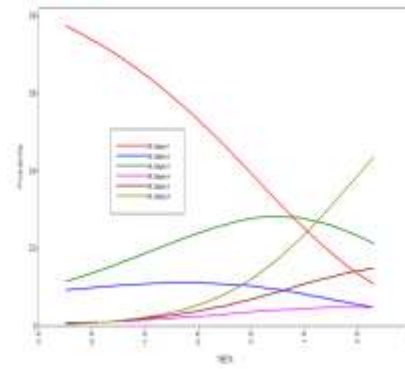
female i4a

The diagram above shows the Item characteristic curve (ICC) for item 4a for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i4a is not invariant.



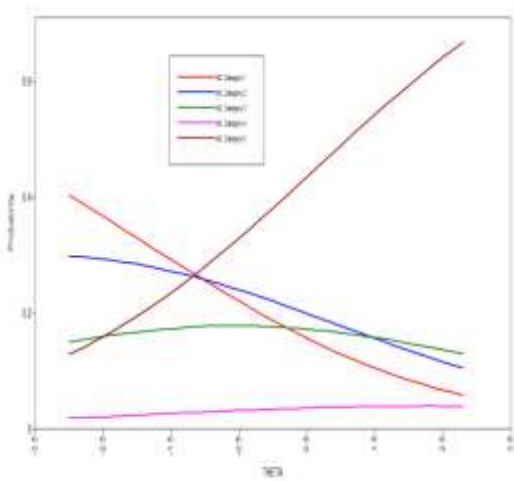


Malei4b

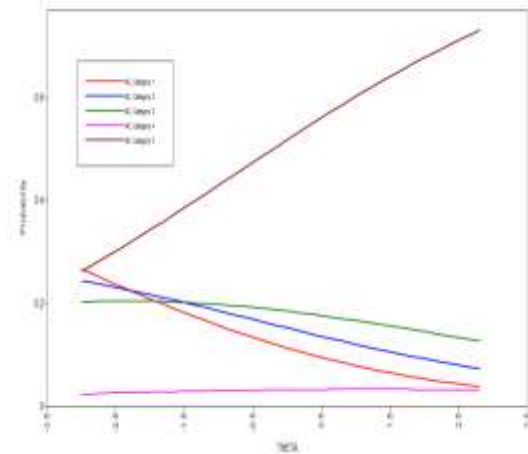


female i4b

The diagram above shows the Item characteristic curve (ICC) for item 4b for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i4b is not invariant.

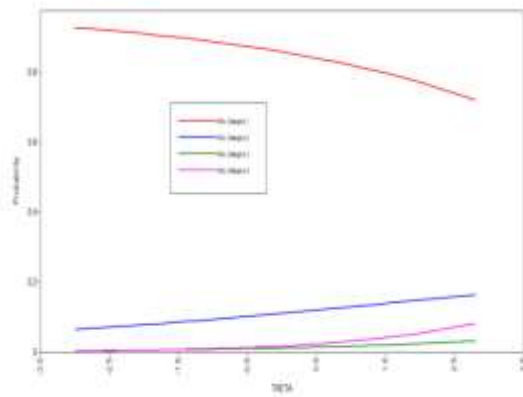


Malei4c

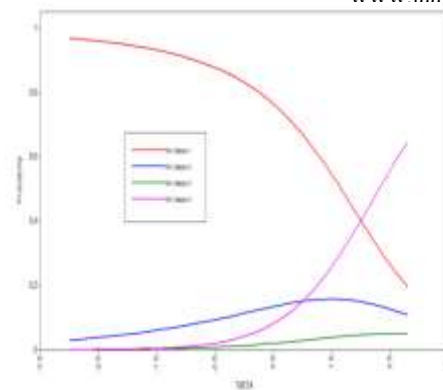


femalei4c

The diagram above shows the Item characteristic curve (ICC) for item 4c for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differs from one another so i4c is not invariant.

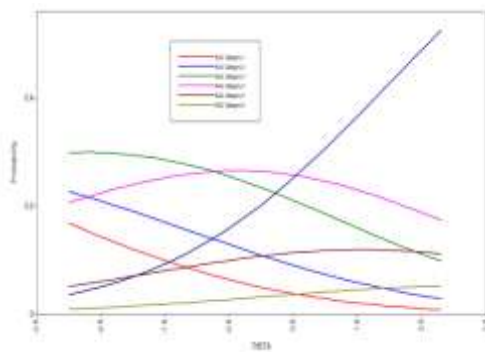


Male i5aI

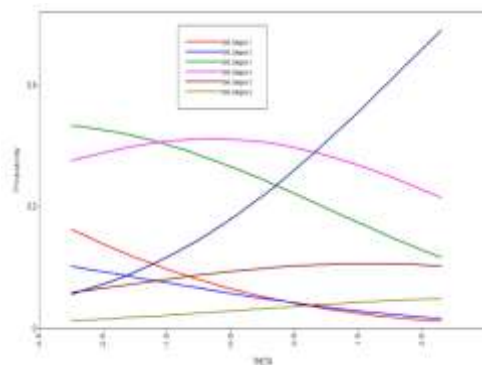


female i5aI

The diagram above shows the Item characteristic curve (ICC) for item i5aI for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differ from one another so i5aI is not invariant.

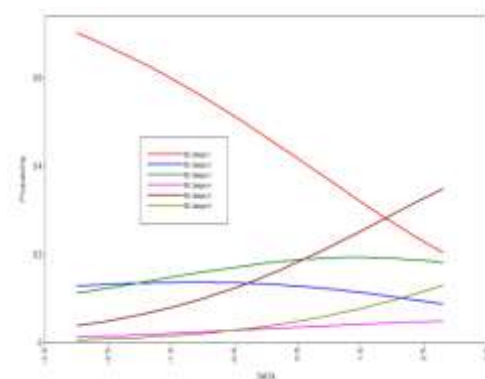


Male i5aII

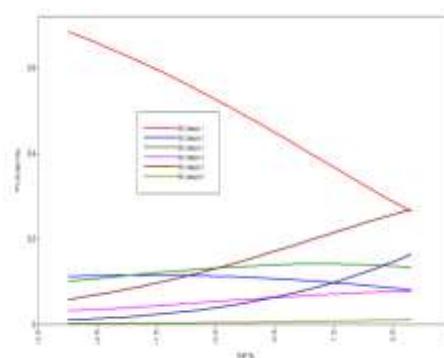


Female i5 II

The diagram above shows the Item characteristic curve (ICC) for item i5aII for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC are closely similar in shape to one another so i5aII is invariant.

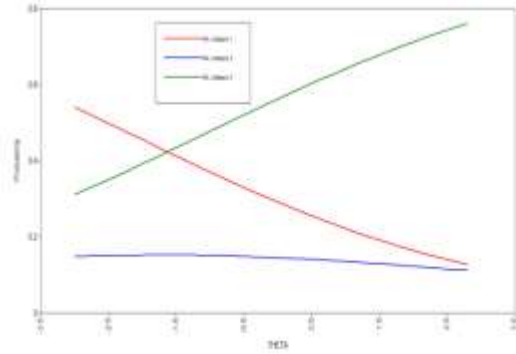


Male i5b

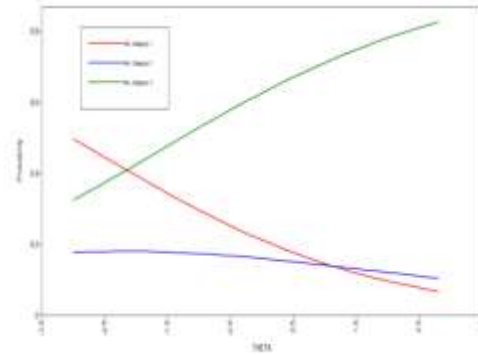


female i5b

The diagram above shows the Item characteristic curve (ICC) for item i5b for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICC differ from one another so i5b is not invariant.

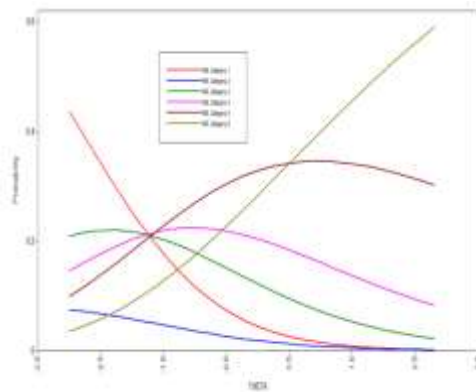


Male i6a

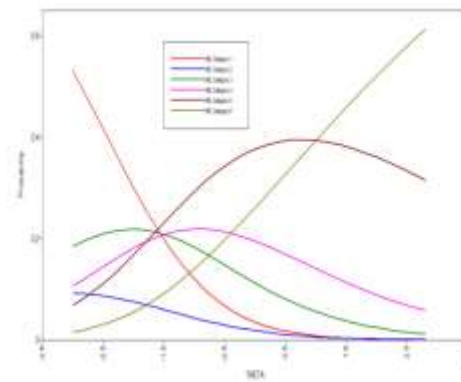


female i6a

The diagram above shows the Item characteristic curve (ICC) for item i6a for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. it was seen that the two ICCs are similar to each other so i6a is invariant.

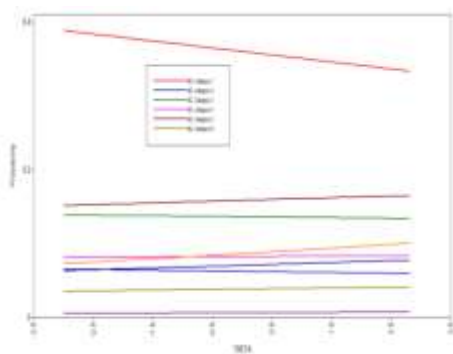


Male i6b

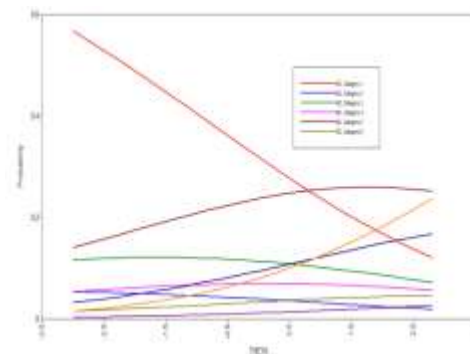


female i6b

The diagram above shows the Item characteristic curve (ICC) for item i6b for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. it was seen that the two ICCs are similar to each other so i6b is invariant.

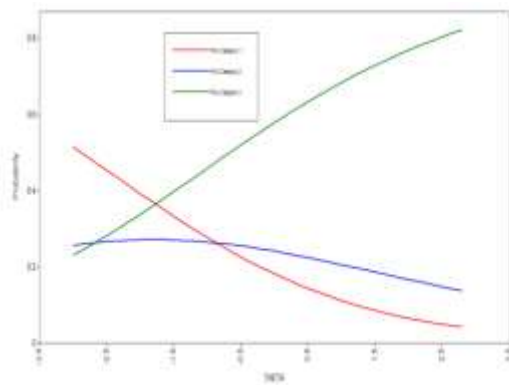


Male i6c

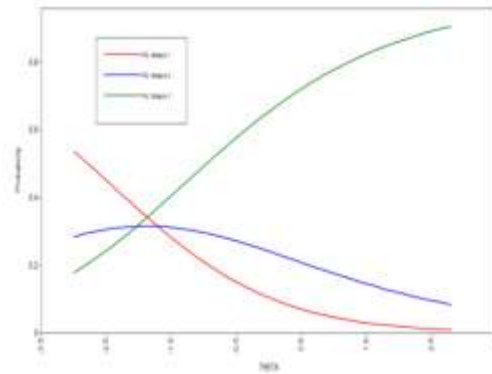


female i6c

The diagram above shows the Item characteristic curve (ICC) for item i6c for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. it was seen that the two ICCs differs to each other so i6c is not invariant.

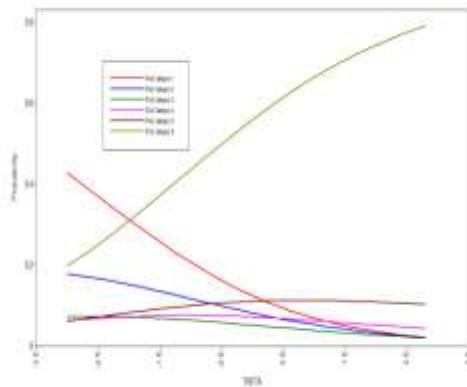


Male i7ai

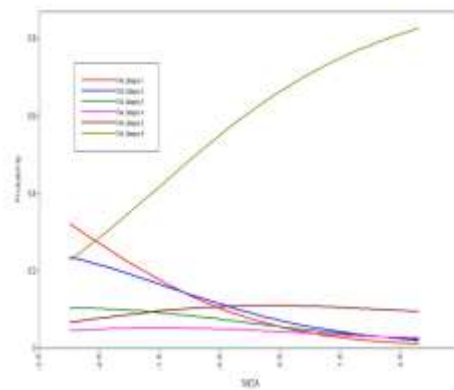


female i7ai

The diagram above shows the Item characteristic curve (ICC) for item i7a for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICCs are similar to each other so i7a is invariant.

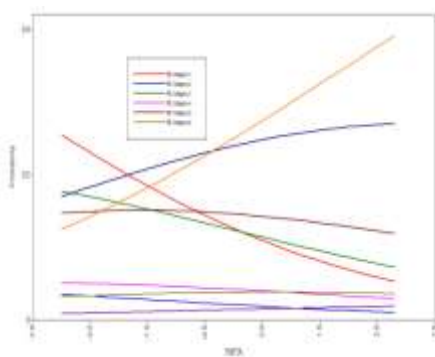


Male i7aii

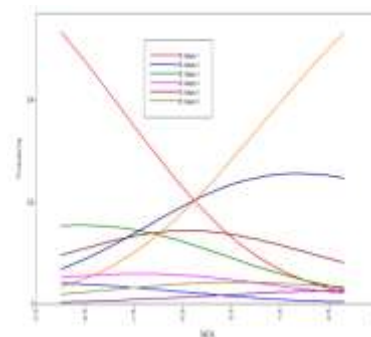


female i7aii

The diagram above shows the Item characteristic curve (ICC) for item i7aii for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICCs are similar to each other so i7aii is invariant.

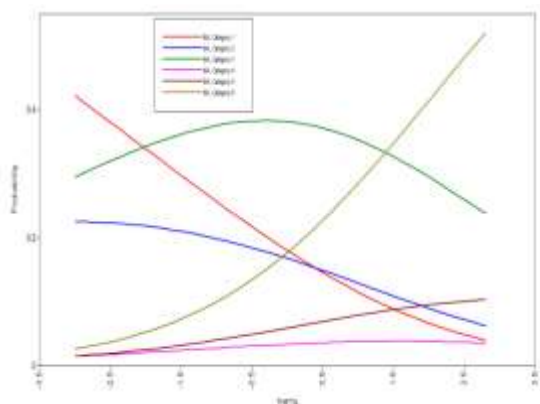


Male i7b

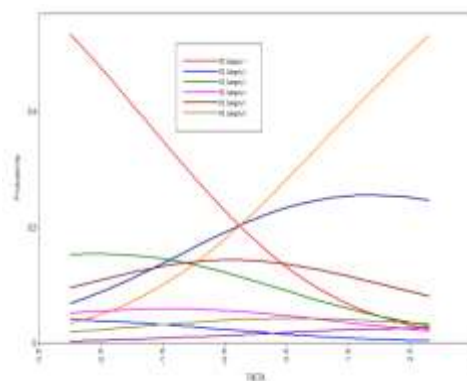


female i7b

The diagram above shows the Item characteristic curve (ICC) for item i7b for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i7b is not invariant.

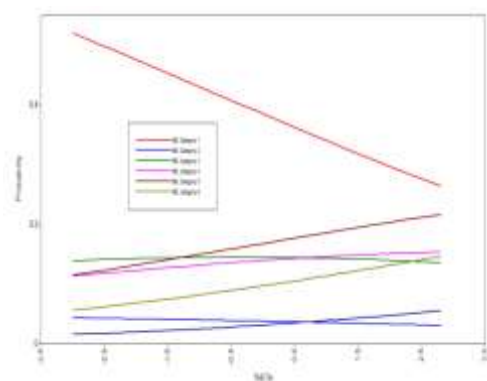


Male i8a

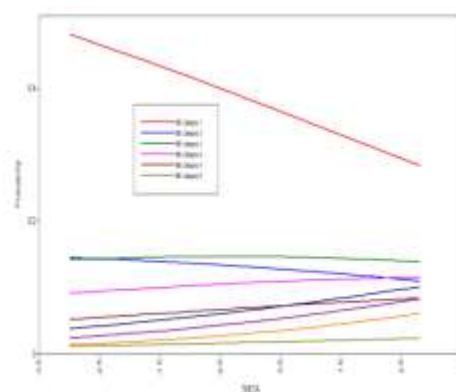


female i8a

The diagram above shows the Item characteristic curve (ICC) for item i8a for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i8a is not invariant.



Male i8b



female i8b

The diagram above shows the Item characteristic curve (ICC) for item i8b for male and female students respectively. To answer research question 1, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i8b is not invariant.

### Research question 2

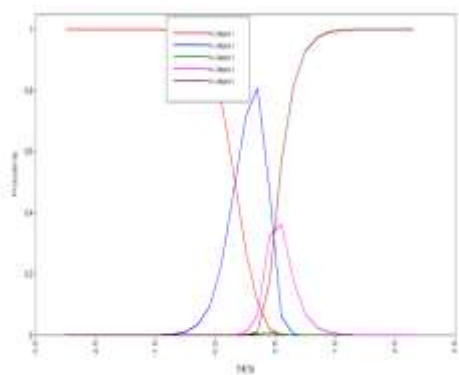
How invariant were the difficulty estimates of test items among Geography students in rural and urban locations in Nigeria?

To answer this research question, the scores of all the 1546 students was divided into two (rural and urban school students). The rural and urban school student

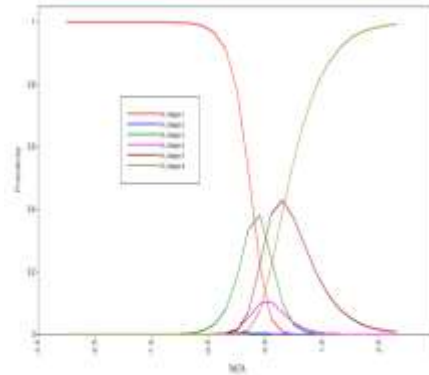
scores were subjected to generalized partial credit model with Mplus 7.4 so as to obtain the difficulty estimate of test items of rural school students. The difficulty estimates for rural and urban school of male and female students as shown in table 2 followed by the item characteristics curves of the items as responded to by rural and urban students respectively.

**Table 2: Difficulty Estimates across Rural-based and Urban-based School Samples**

| Item  | Rural    | Urban    |
|-------|----------|----------|
| I1A   | 0.3      | 0.515    |
| I1B   | 0.673    | 1.073    |
| I1C   | 1.434    | 3.066    |
| I1D   | 0.5      | 1.365    |
| I2A   | -6.87    | 2.55     |
| I2B   | 3.124    | -2.636   |
| I2C   | -0.851   | -5.629   |
| I3A   | -1.11    | -0.247   |
| I3B   | 1.572    | 9.986    |
| I4A   | -1.258   | 0.758    |
| I4B   | -12.181  | 1.892    |
| I4C   | -3.65    | -1.391   |
| I5AI  | 3.504    | 2.83     |
| I5AII | -4.525   | -0.85    |
| I5B   | -15.218  | 1.912    |
| I6A   | -2.605   | -1.828   |
| I6B   | -2.04    | -0.887   |
| I6C   | -2.27    | 2.585    |
| I7AI  | -1.287   | -2.914   |
| I7AII | -1.247   | -6.348   |
| I7B   | -2.5     | 0.063    |
| I8A   | -0.429   | 0.131    |
| I8B   | 1.446    | -8.635   |
| Mean  | -1.97774 | -0.11474 |
| STD   | 4.419633 | 3.753513 |

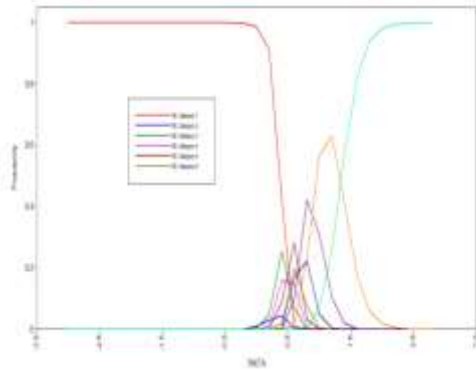
**URBAN AND RURAL ITEM CHARACTERISTIC CURVES**

Rural i1a

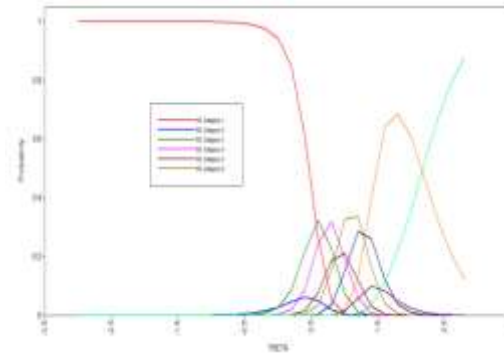


urban i1a

The diagram above shows the Item characteristic curve (ICC) for item i1a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i1a is not invariant.

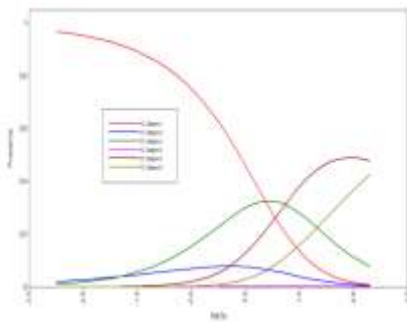


Rural i1b

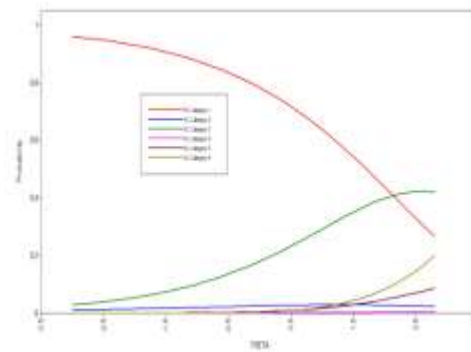


urban i1b

The diagram above shows the Item characteristic curve (ICC) for item i1b for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i1b is not invariant.

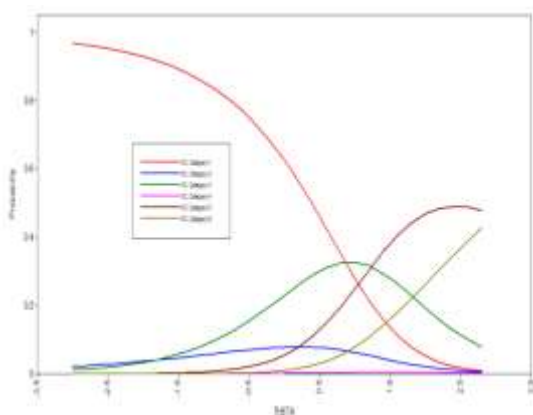


Rural i1c

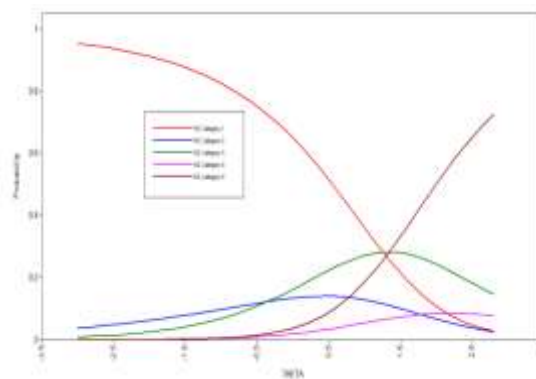


female i1c

The diagram above shows the Item characteristic curve (ICC) for item i1c for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i1c is not invariant.



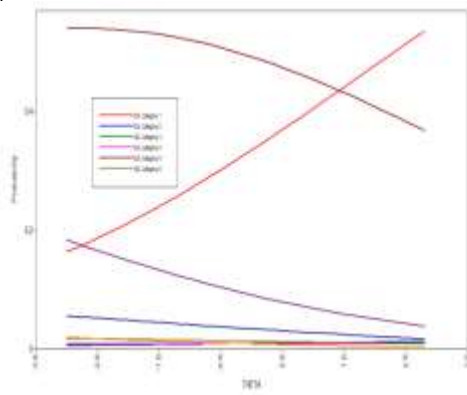
Rural i1d



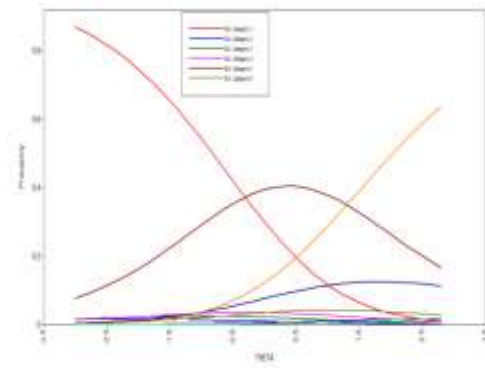
urban i1d

The diagram above shows the Item characteristic curve (ICC) for item i1d for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i1d is not invariant.



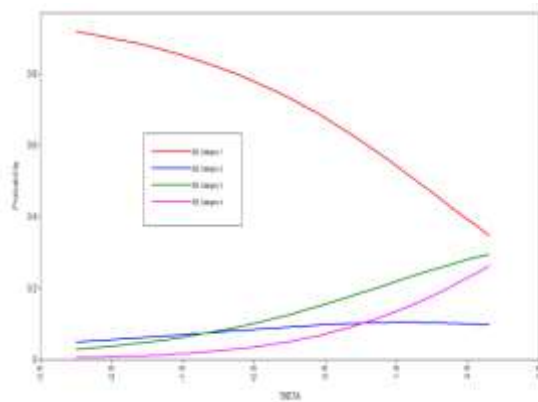


Rural i2a

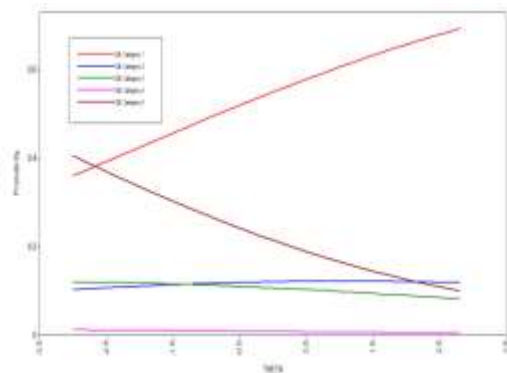


urban i2a

The diagram above shows the Item characteristic curve (ICC) for item i2a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i2a is not invariant.

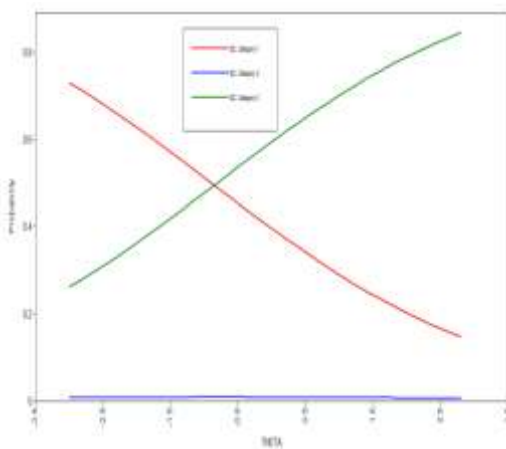


Rural i2b

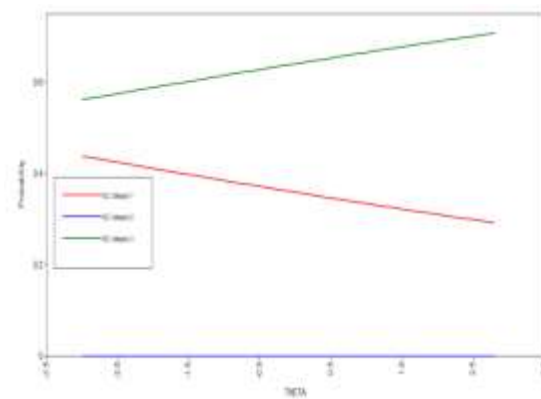


urban i2b

The diagram above shows the Item characteristic curve (ICC) for item i2b for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i2b is not invariant.



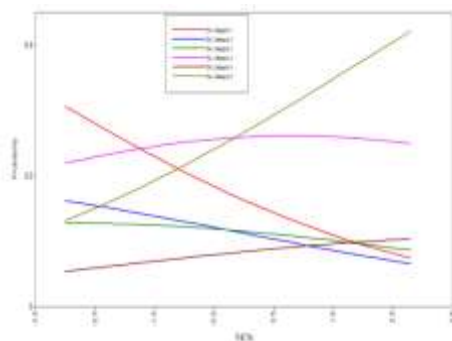
Rural i2c



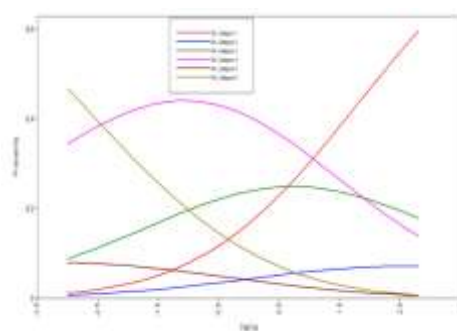
urban i2c



The diagram above shows the Item characteristic curve (ICC) for item i2c for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i2c is not invariant.

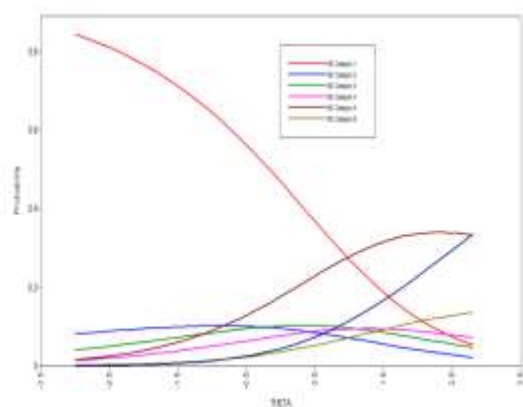


Rural i3a

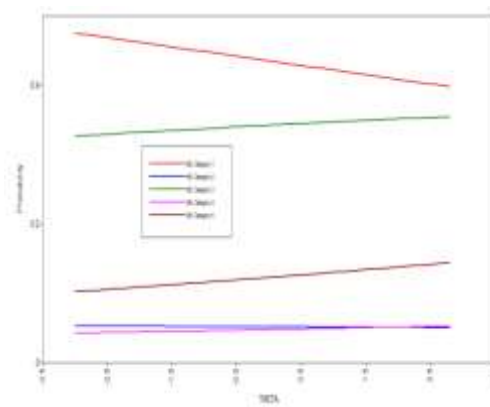


female i3a

The diagram above shows the Item characteristic curve (ICC) for item i3a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i3a is not invariant.

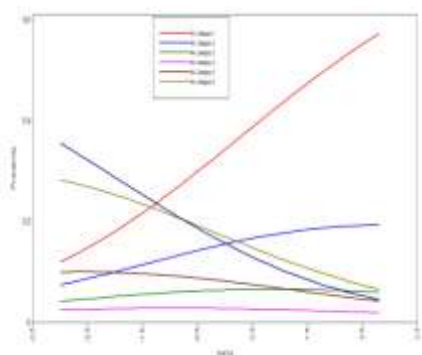


Rural i3b

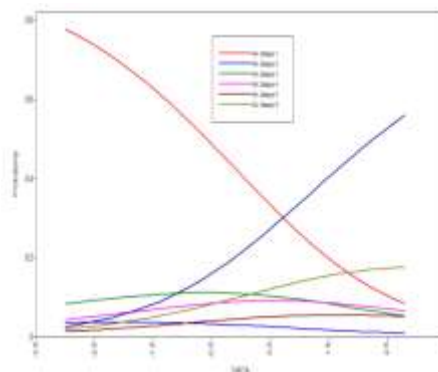


urban i3b

The diagram above shows the Item characteristic curve (ICC) for item i3b for rural and urban students respectively. To answer research question 1, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i3b is not invariant.

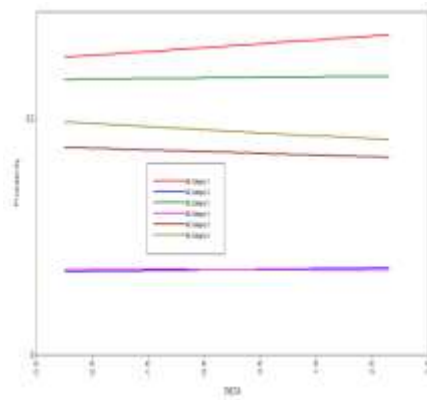


Rural i4a

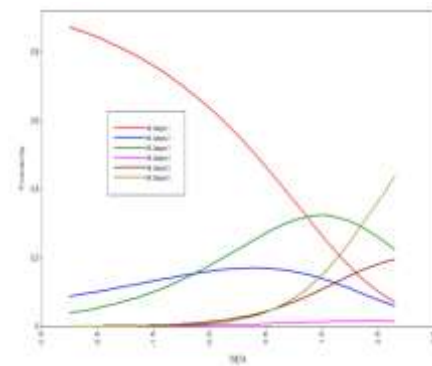


urbani4a

The diagram above shows the Item characteristic curve (ICC) for item i4a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i4a is not invariant.

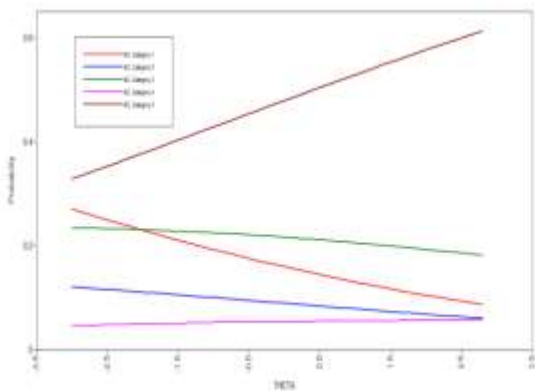


Rural i4b

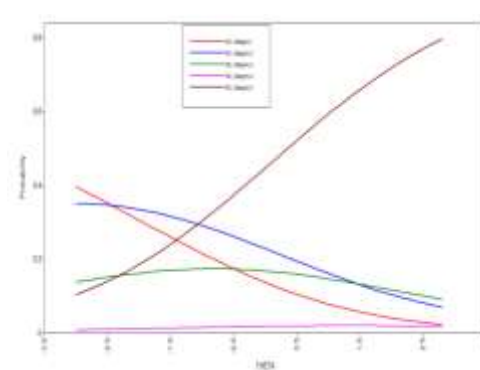


urban i4b

The diagram above shows the Item characteristic curve (ICC) for item i4b for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i4b is not invariant.

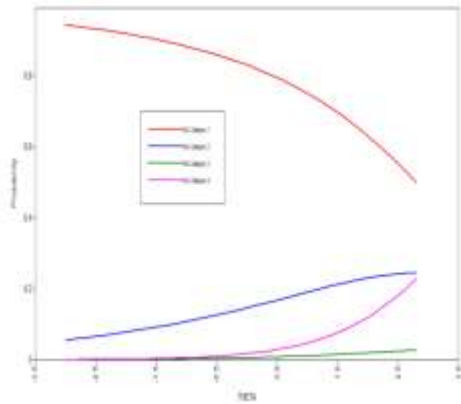


Rural i4c

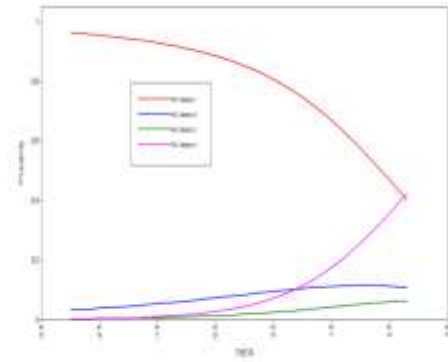


urban i4c

The diagram above shows the Item characteristic curve (ICC) for item i4c for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i4c is not invariant.

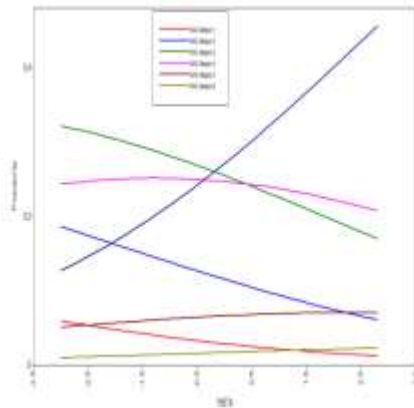


Rural i5ai

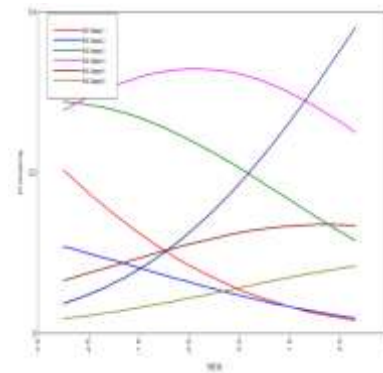


urban i5ai

The diagram above shows the Item characteristic curve (ICC) for item i5a1 for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i5a1 is not invariant.

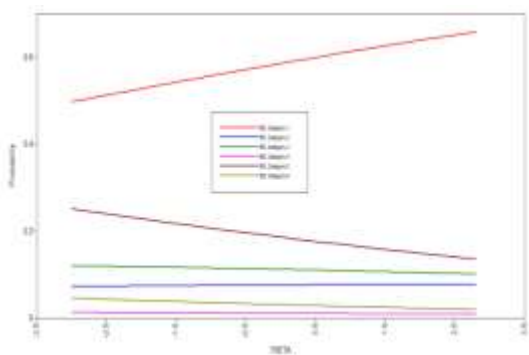


Rural i5aii

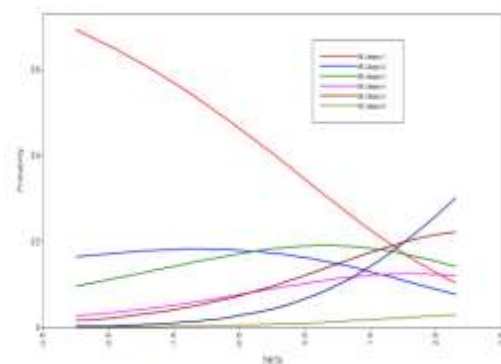


urban i5aii

The diagram above shows the Item characteristic curve (ICC) for item i5aii for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i5aii is not invariant.

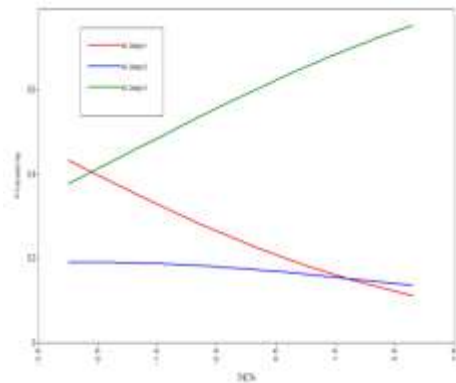


Rural i5b

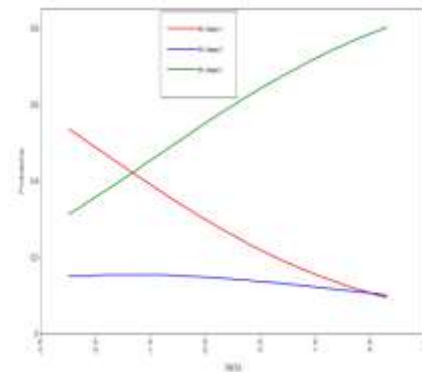


urban i5b

The diagram above shows the Item characteristic curve (ICC) for item i5b for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i5b is not invariant.

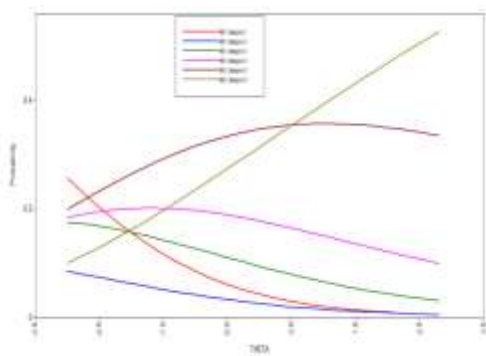


Rural i6a

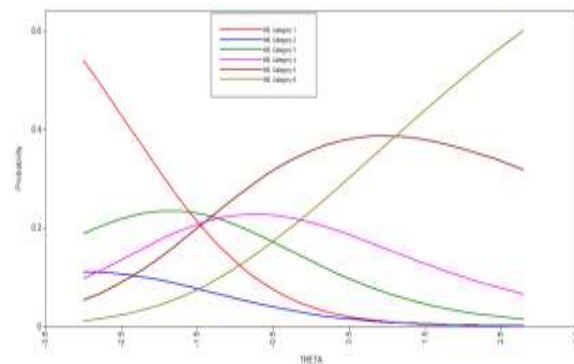


urban i6a

The diagram above shows the Item characteristic curve (ICC) for item i6a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs are similar to each other so i6a invariant.

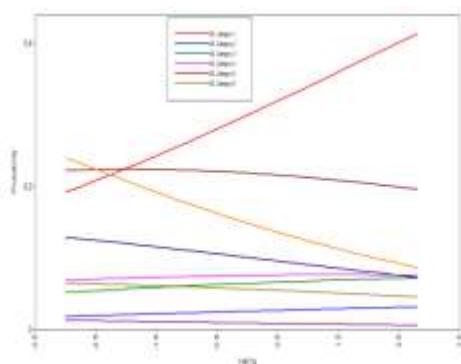


Rural i6b

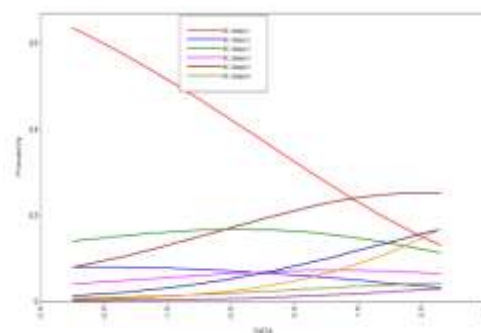


urban i6b

The diagram above shows the Item characteristic curve (ICC) for item i6a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. it was seen that the two ICCs differ from each other so i6b is not invariant.

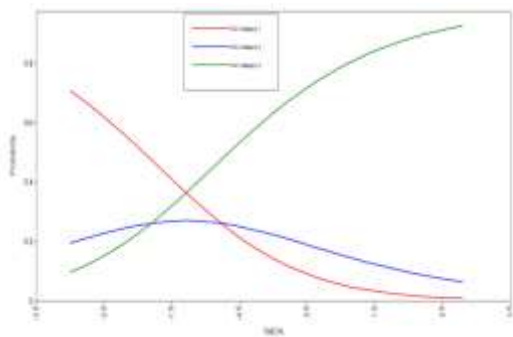


Rural i6c

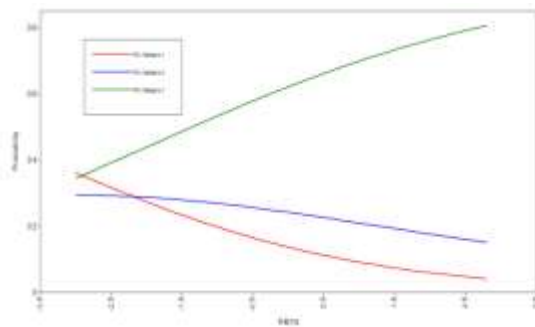


urban i6c

The diagram above shows the Item characteristic curve (ICC) for item i6c for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i6c is not invariant.

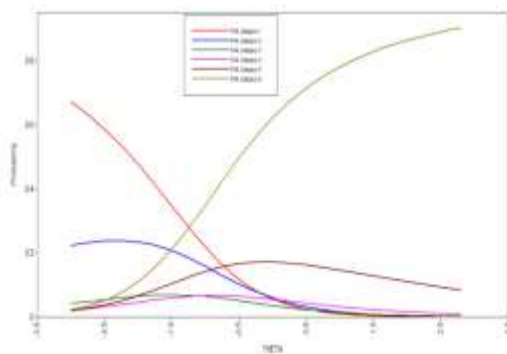


Rural i7ai

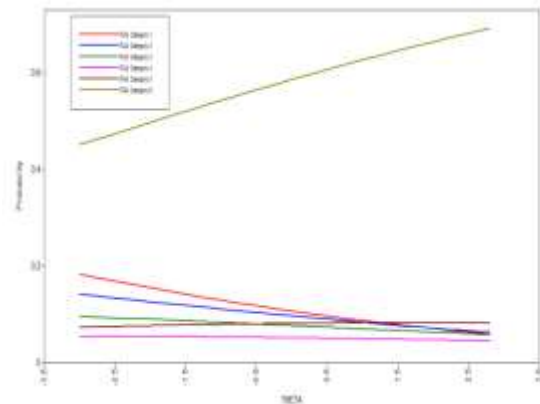


Urban i7ai

The diagram above shows the Item characteristic curve (ICC) for item i7ai for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i7ai is not invariant.

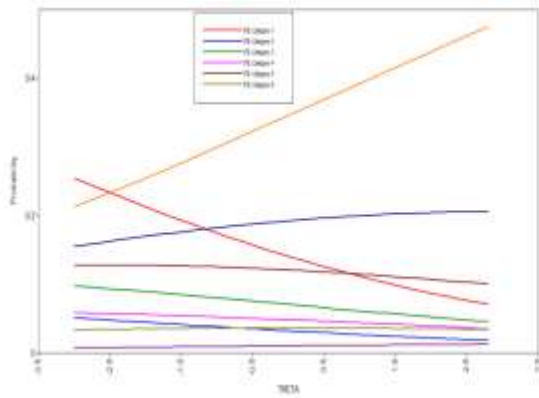


Rural i7aai

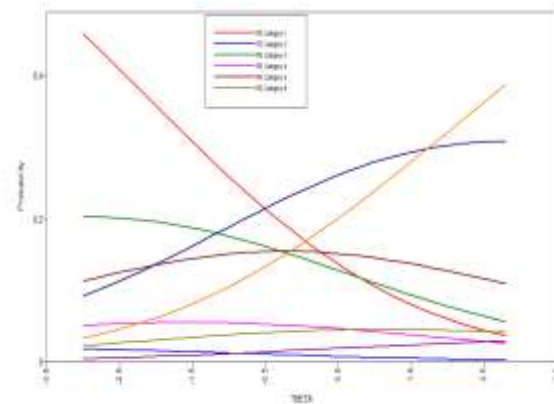


Urban i7aai

The diagram above shows the Item characteristic curve (ICC) for item i7aai for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i7aai is not invariant.

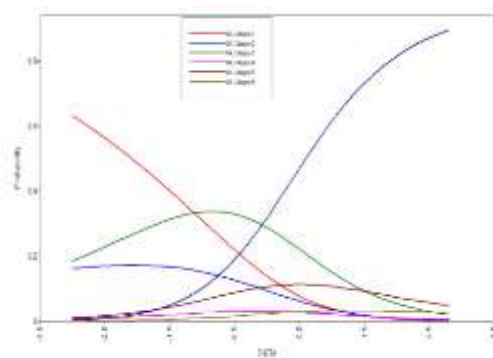


Rural i7b

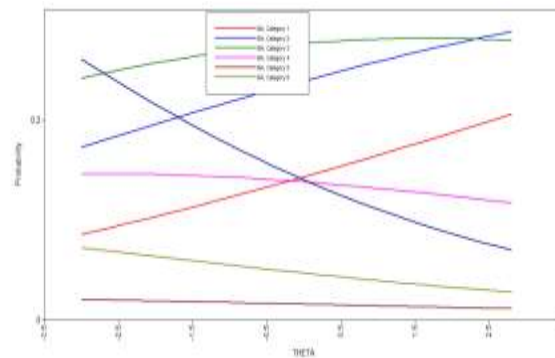


Urban i7b

The diagram above shows the Item characteristic curve (ICC) for item i7b for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i7b is not invariant.

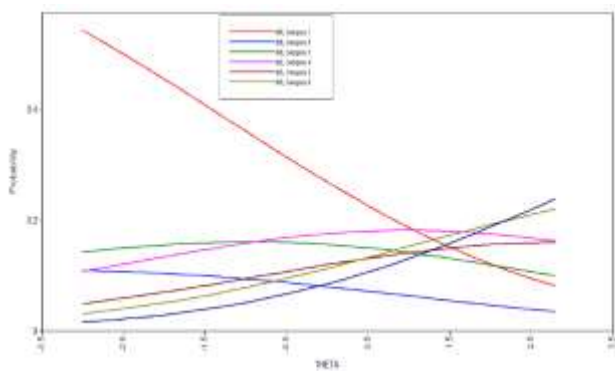


Rural i8a

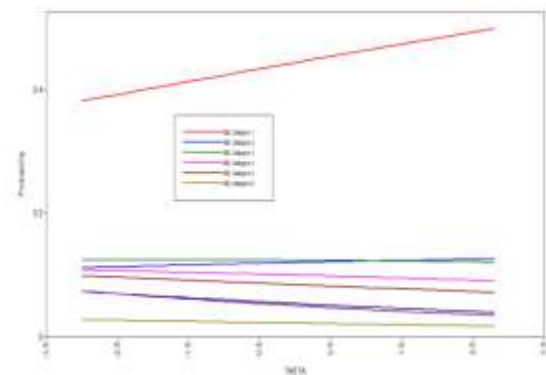


Urban i8a

The diagram above shows the Item characteristic curve (ICC) for item i8a for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i8a is not invariant.



Rural i8b



Urban i8b



The diagram above shows the Item characteristic curve (ICC) for item i8b for rural and urban students respectively. To answer research question 2, the ICC above were observed to make comparison. It was seen that the two ICCs differ from each other so i8b is not invariant.

### DISCUSSION

Findings of the study indicated that in research question one, most of the items were not invariant this was because sixteen items showed an obvious variation among males and females' except for seven items that were invariant among males and females. Findings of the study revealed that 16 items (1,3, 5, 6, 7, 8,9, 10, 11, 12,13,15,18,21, 22 and 23) of the geography test had difficulty estimates among male geography students that were obviously at variance with the items' difficulty estimates in the female geography students. The reason may be because the test items were constructed based on CTT but the study used IRT to estimate ability. This result is in line with the study of Filgona and Sababa [7] in their study, effect of gender on senior secondary school academic achievement in geography where mastery learning strategy and conventional method were used for instruction. The study revealed that achievement of female student improved significantly compared to their male counterpart in the use of mastery learning strategy. The finding is in line with the work of Adedoyin [8], investigating the invariance of person parameter estimates based on classical test and item response theories which revealed that there is lack of invariance when CTT is used to estimate examinee ability. The finding is against the work of Adedoyin et al. [9] that investigated the invariance of item difficulty

parameter estimates based on CTT and IRT. Findings from the study showed that IRT item difficulty parameter estimates were invariant across different independent samples of persons while CTT item difficulty parameter estimates across different independent samples of persons were variant.

Also, findings of the study revealed that 22 items (1,2,3, 4,5, 6, 7, 8,9, 10, 11, 12,13,14,15,17,18,19,20,21, 22 and 23) of the geography test had difficulty estimates among rural and urban geography students that were obviously at variance with the items' difficulty estimates in the female geography students. More importantly, on the individual ground, most of the items showed dissimilar difficulty parameter estimates in the two contrasting samples. The implication of the results is that the extent of variation of the difficulty of the Physical geography test items with respect to school location was very large. This result is in line with the work of Agbaje and Awodun [10] works revealed difference in the achievement of students in rural and urban schools also, [8] study revealed that school location has significant effect on students' achievement in chemistry. The result of the study is against the work of Adedoyin et al. [9] work on investigation of invariance of item difficulty parameter estimates based on CTT and IRT.

### CONCLUSION

It could be concluded from the findings that the invariance of item parameters of polytomous geography items in senior school certificate examination in Nigeria for 2016 WAEC paper 3 was low among male and

female geography students and among schools located in rural and urban areas. This was because most of the items were not invariance which implies that the test was not good for group comparison.

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